CHASSIS Lubricate for SAFETY every 1,000 MILES LUBRICATION

The Institute Spokesman

NATIONAL LUBRICATING GREASE INSTITUTE

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Greases for the Bureau of Ships

By Lt. F. A. Christiansen, U. S. Navy, Bureau of Ships

Presented at 12th Annual Meeting, N. L. G. I.

At the present time the Bureau of Ships is meeting most of its shipboard grease requirements with the following types of greases:

(1) Cup grease, specification 14-G-1
(2) Ball and Roller Bearing Lubricant, Specification 14-L-3
(3) Graphite grease, specifications 14-L-12 or VV-G-671
(4) Turret Roller and Pinion Lubricant 14-L-8
(5) High Temperature Lubricant 14-L-7

With the exception of Turret Roller and Pinion Lubricant, most grease manufacturers make the other four types of lubricants. In saying "types" it is not to be inferred that most manufacturers have products that meet the requirements of the specifications as written.

The mineral lubricating grease purchased under Navy Department Specification 14-G-1 requires a lime soap and oil of 125 seconds minimum Saybolt Universal Viscosity in NLGI penetration grades 1, 2, and 3.

Graphite greases purchased under Bureau of Ships Ad Interim Specification 14-L-12 (INT) and Federal Specification VV-G-671a(1) have the same requirements as the mineral grease just described and in addition, two to three percent of graphite having a graphitic carbon content of 95 percent minimum. The necessity for using these graphited greases aboard ship to the extent that they are being used at present is in question. It will be appreciated if those present here and those interested in graphited greases will contact the Bureau of Ships in person or by letter to describe the applications where graphited greases are indispensable.

Ball and Roller Bearing Lubricant purchased under Bureau of Ships Ad Interim Specification 14-L-3 (INT) is a mixed base, soda-lime soap grease in NLGI grades 1, 2, and 3. Oil viscosities at 100°F for each of the three grades in order are (1) 150-250, (2) 200-300, (3) 250-350. The calcium oxide content determined on the ash must be between 0.1 and 0.5 percent.

Some misapprehensions exist as to the suitability of 14-L-3 greases for electric motor applications. Investigations by qualified men have shown that the grease is performing satisfactorily and that the operating personnel of some ships cause motor failures by overlubrication. No failures were reported due to underlubrication. One ball-bearing failure epidemic in fire and bilge pump motors was found to be caused by poor design rather than grease oxidation. In general, grease lubrication maintenance practices aboard ship are satisfactory except where the appearance of grease brand names appears in maintenance manuals supplied with equipment, but more will be said of this later.

The program underway to use motors whose bearing temperatures exceed 90°C. has brought about the revision of Specification 14-L-7(INT), High Temperature Lubricating Grease. Copies of the revised specification will be available in November. The specification is essentially the same as Army-Navy Aeronautical Specification AN-G-5a (to be issued soon) except that Bureau of Ships will not require water resistance. Water resistance is a desirable feature and will eventually be included in the specification when it is ascertained that sufficient supplies will be available for both aircraft and shipboard uses. The primary simulated service requirement of the new 14-L-7 specification is that the grease satisfactorily lubricate a No. 204 ball bearing when the bearing is rotated at 10,000 rpm and the temperature is maintained at 300°F for 300 hours operating time, rotation being stopped and the bearing cooled to room temperature after each 22 hours of operation. It is hoped that eventually a high temperature ball and roller bearing lubricant specification covering a single grade will replace the present three grades of 14-L-3 and the one grade of 14-L-7.

Turret Roller and Pinion Lubricant purchased under Bureau of Ships Ad Interim Specification 14-L-8(INT), recently revised, requires an NLGI grade 1 grease having extreme pressure properties and the ability to adhere to a vertical surface. It must also protect steel from corrosion in humid climates. There is no composition limitation in the specification.

Bureau of Ships Specification 14-L-4 (INT) for Universal Gear Lubricants is dormant at the present time and purchases are being made under US Army Specification 2-105A.

Bureau of Ships Specification 14-L-5 (INT), Non-Slick, Waterproof Lubricants, is also a dormant specification pending completion of a survey being made to determine the necessity of having such a material. The specification in its present form provides for a grade 4 grease which is too hard for general submarine outboard lubrication. It is probable that the specification will be cancelled and superseded by Navy Department Specification 14-L-11 for waterproof grease applications requiring a grade 4 grease and superseded by specification 14-G-1 for applications requiring a softer grease.

(Continued on Page 4)

Some Practical Methods for the Evaluation of Lubricating Greases

By L. W. SPROULE*, Sarnia, Ontario

(Continued from February Issue)

The results of these experiments with four experimental greases are shown in Figure No. IX.

In this graph the torque values of the various experimental greases described in Figure No. VII are plotted against the viscosity of the greases measured at 340 sec. $^{-1}$ rate of shear. It will be observed that the relationship between viscosity of the greases and torque values obtained with the sleeve bearing are almost directly proportional as required by theory. Unfortunately, no method is as yet available for determining the actual rate of shear in an anti-friction bearing, therefore, the torque results obtained with the Norma Hoffman bearing are not strictly comparable with the viscosity measurements as they were not carried out at the same rate of shear. However, the results are of considerable interest. In the case of greases Nos. 1, 2 and 4 the maximum torque and torque after 15 minutes' operation was found to increase with the increase in viscosity of the grease. In the case of grease No. 3 the torque after 15 minutes' operation was zero, indicating exceptionally good low temperature characteristics. The explanation of this peculiar behaviour is the fact that grease No. 3 channelled. While this grease had a relatively high starting torque during the first few minutes of operation, subsequent starts could be made with practically no power loss.

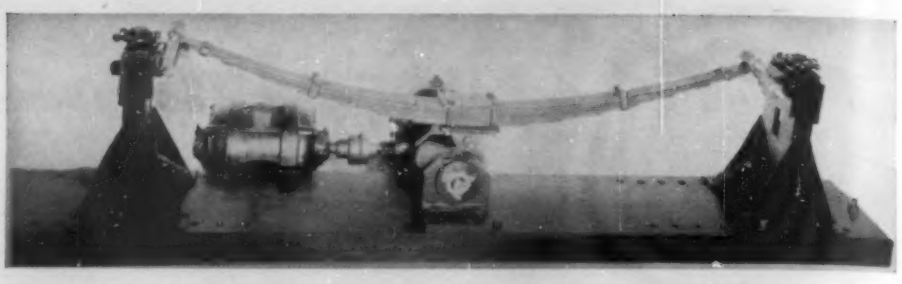
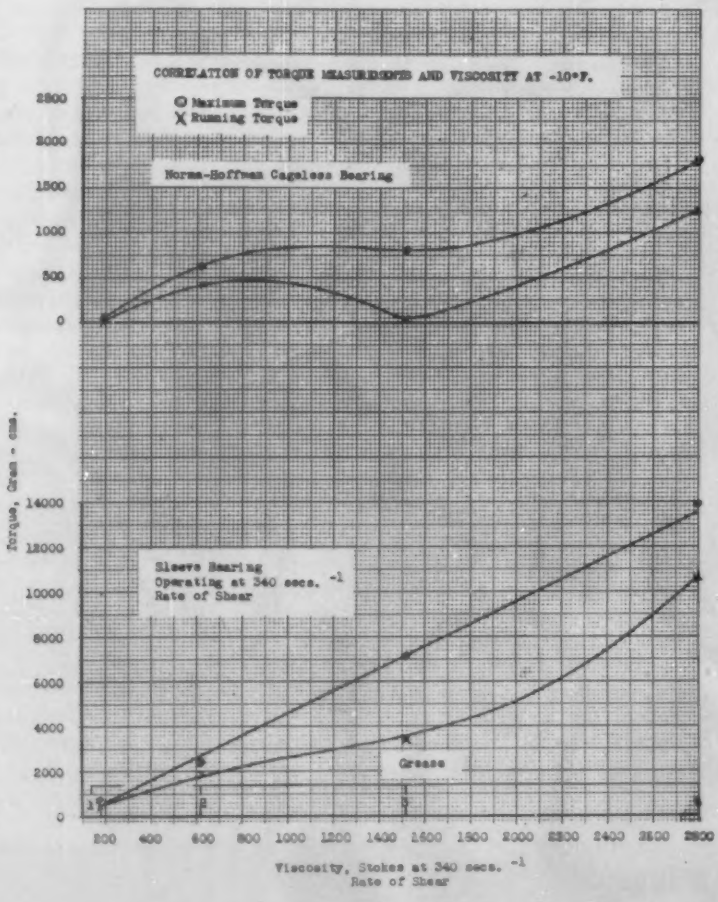


FIGURE No. X
Shackle Machine for Evaluating Chassis Lubricants

FIGURE No. IX



These data indicate that torque tests with anti-friction bearings cannot be used as a general criteria for predicting the low temperature properties of greases. Such measurements apply only to the type of bearing used and to the conditions under which the test is made. In the lubrication of sliding surfaces where channelling is likely to be absent, the low temperature properties can be determined satisfactorily by measuring the torque with sleeve bearings or determining the viscosity of the grease with a pressure viscometer.

(e) CHASSIS LUBRICANTS

Probably one of the largest single uses for grease is the lubrication of chassis parts on automotive vehicles. However, a review of the literature indicates that this application appears to be one which has received the least attention from grease manufacturers.

The retention properties of various greases in automotive shackles were studied by means of a laboratory machine as shown in Figure No. X.

The apparatus consisted of a Chevrolet rear spring supported by two plain shackles and was actuated by a motor driven cam. The cam was so designed that in addition to 60 jolts per minute it also imparted a side throw to the spring, simulating side sway in a car. This mechanism imparted a minimum deflection of ¾" and a maximum of 2" to the spring.

Tests were carried out by charging a shackle with a known amount of grease and

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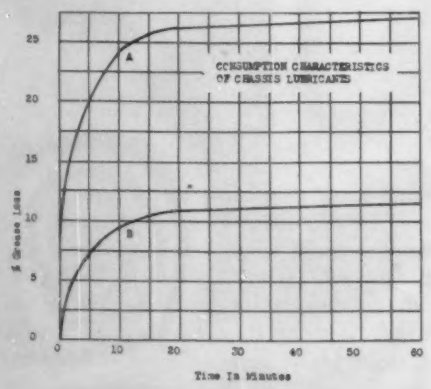

FIGURE No. XI

measuring the leakage from the shackle at various intervals over a period of one hour. Between each test the shackle assembly was dismantled and thoroughly cleaned. Typical results for two greases are shown in Figure XI.

It will be observed that for both greases the leakage from the shackle was rapid during the first 15 minutes, becoming almost constant after one hour. Grease A was one of the poorest greases examined, while Grease B showed considerably better performance, the actual losses being 27 and 11% respectively. The reproducibility of the determinations was found to be ±1.2%. The results of field tests compared very favourably with the laboratory evaluations.

The evaluation of chassis lubricants by this machine required a specialized technique and it was felt desirable to develop a method which would be less time consuming. A number of years ago when development work was carried out on a pressure viscometer it was observed that a relationship existed between the slope of the pressure flow curves obtained by means of a pressure viscometer and the consumption characteristics of the lubricants measured on the shackle machine. In Figure No. XII are shown the pressure flow curves of a number of greases which had been evaluated on the shackle machine.

It was found that a straight line relationship resulted when the per cent consumption measured after one hour on the shackle machine was plotted against the slope of the pressure flow curves at 533 sec. $^{-1}$ rate of shear. This relationship is shown in Figure No. XIII.

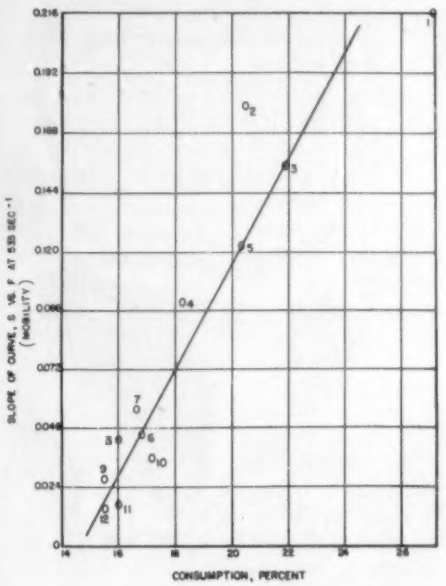

Figure No. XIII

Correction of Slope of Pressure Flow Curves with Consumption Characteristics of Chassis Lubricants

Thus a method is available for the evaluation of chassis lubricants in fundamental units by measuring their flow properties.

CONCLUSIONS

A brief description has been given of methods which have proven satisfactory for the evaluation of lubricating greases.

In the development of these tests, two factors were kept in mind:

(a) the necessity for developing laboratory methods which would evaluate the performance of greases under the

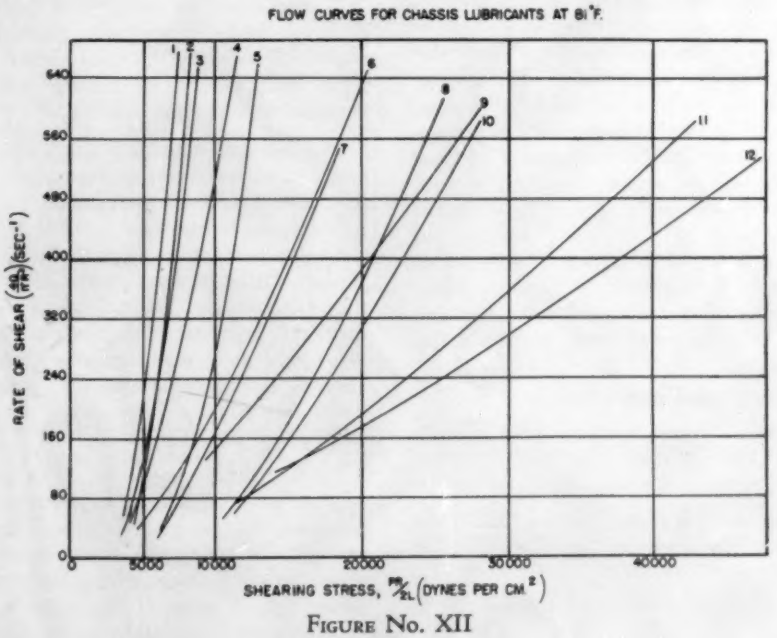

FIGURE No. XII

operating conditions encountered in field service,

(b) the desirability of evolving, wherever possible, laboratory test procedures which would express the results in terms of the fundamental properties of greases.

Of the test methods discussed, those for evaluating wheel bearing greases and for determining the consumption characteristics of brick greases are considered practical tests. While the results are readily reproducible, they do not relate to any fundamental property of the grease and apply only to the apparatus in question. On the other hand, the method for the evaluation of the low temperature properties of greases relate to the behaviour of basic flow properties of the lubricant, thus a direct correlation between laboratory data and field experience is possible. Measurements of this type are readily reproducible in most laboratories even though different apparatus is used. In the evaluation of lubricants for some applications it may seem impossible to employ methods which embody fundamental measurements. However, a great deal can be accomplished by correlating the results of practical tests with basic properties of the lubricants. For example, it was necessary to use a complicated apparatus in the evaluation of chassis greases. Further development work, however, made it possible to correlate these results with the flow properties of greases as determined on a pressure viscometer thus obviating the erroneous practical testing of this type of lubricant.

From the foregoing discussion it would seem necessary for the grease industry to adopt methods of evaluation which express fundamental properties of soap oil systems. Unless grease manufacturers, equipment builders and consumers co-operate with this objective in view, a number of arbitrary testing methods will be developed for evaluating essentially the same characteristics of greases. Some progress on the development of basic methods of evaluation has already been made by previous investigators (3, 4) in the measurement of the flow properties of greases. There are, however, many other fundamental properties of greases which have yet to be investigated and which, no doubt, can be correlated with practical methods.

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1. Blackwood and Spencer — S.A.E.J. 29, 53, 1934
2. Klemgard—Lubricating Greases, 1937
3. Beebower, Sproule, Patberg and Zimmer—The Institute Spokesman, 6, 4, 1942
4. Zimmer—The Institute Spokesman, 7, 1, 1943

Greases for the Bureau of Ships

(Continued from Page 1)

The Engineering Experiment Station is at the present time conducting work toward the development of a specification for plug valve lubricants which must resist water and 100-octane gasoline.

Bureau of Ordnance Specification O.S. 1350 entitled "Bearing Grease for General Use in Naval Ordnance" covers a grease having good low temperature properties and is used quite extensively on ordnance equipment and in a few applications other than ordnance equipment to obtain the advantage of its good low temperature properties on equipment mounted topside.

General Purpose No. 1 Lubricant covered by specification 14-L-9 (which is identical to U. S. Army Specification 2-107) is used primarily on automotive equipment and landing craft and is not used for general shipboard machinery lubrication.

General Purpose No. 2 Lubricant intended for wheel bearing lubrication is likewise not a shipboard lubricant. Specification 14-L-10 covering this product is being revised to conform to the revision being made in U. S. Army Specification 2-108. The important changes in the revision are (1) increase of melting point to 300°F minimum, (2) requiring a soda soap and allowing a small amount of aluminum or lime soap not exceeding 10% of the total soap content and (3) insolubles determination to be made using petroleum ether and eliminating the use of carbon bisulfide.

Waterpump Lubricant No. 4 under specification 14-L-11 is likewise identical to the corresponding U. S. Army Specification 2-109 and is used on landing craft and automotive equipment primarily.

The Bureau of Ships is gradually eliminating any reference to brand names of lubricants in instruction books for individual items of equipment and is requiring their replacement by Navy Specification product. All petroleum manufacturers and their salesmen and lubrication engineers are requested to cooperate in this program. If Navy equipment manufacturers request lubricant recommendations for instruction books, the suitable Navy types should be specified.

If the proprietary name of a product appears in an equipment maintenance manual and that manual becomes approved without eliminating the brand name, operating personnel may relubricate with the wrong type or grade of Navy grease which in turn may result in equipment breakdown. Anyone who knowingly has any part in allowing the appearance of that brand name in place of the Navy designation is more responsible for that failure than the man who put the wrong lubricant in the equipment.

Then there is the case of the instruction book which says to use long fibre grease, medium fibre grease, short fibre grease, and universal joint grease. The activity requiring these may not know what Navy types are applicable and so will order them by the instruction book description. The requisition will get to a Supply Officer who will attempt to assign a Navy type grease without any information available on which to base his decision and his decision can easily be wrong. The receipt of such a requisition can also cause a great amount of delay if the supply activity has to wait for technical assistance to ascertain what Navy types are to replace the brand names or texture descriptions.

There have been and still are many equipment manufacturers who have been so thoroughly sold on a particular brand of grease that they shudder at the thought of using any other grease in their equipment. Such an attitude has its advantages for domestic commercial use of equipment in offering better maintenance but to the Navy it only causes confusion.

At this time the Bureau of Ships would like to request from each grease manufacturer present, that he send to the Bureau a list of all the greases he makes including in so far as possible all the rebrands for each grease with enough of a description of each so that the Bureau may determine what Navy type is suitable as a replacement. This information will be held in strictest confidence and used only for correcting instruction books and to answer inquiries from the fleet for replacement products.

As a warning to grease manufacturers the packaging and marking requirements of grease specifications and of contracts are being made more strict and more practical for Naval use. These restrictions are brought about through sad experience with leakers and inferior outside packaging receiving more severe handling than it can stand. Both of these have caused repackaging at Naval Supply Depots before overseas shipment could be undertaken and such repackaging uses up extra man hours.

The following is an excerpt from Bureau of Ships Ad Interim Specification 14-L-12 (INT) of 1 June 1944 on packaging, packing, and marking for shipment:

G-1. *Packaging.*—Unless otherwise specified, the subject commodity shall be packaged in 1-pound cans, 5-pound, 10-pound, or 25-pound steel pails, or in drums with an approximate capacity of 100 pounds, as follows:

G-1a. One-pound cans shall be made of special coated manufacturer's terneplate and steel pails shall be made of bonderized blackplate. One-pound cans shall be multiple friction top type. The bottom and ring shall be doubleseamed and compound lined. The sideseam shall be soldered and thoroughly wiped to remove excess solder. The plug shall be multiple friction type expressly made to fit the ring and shall be capable of providing a leakproof closure. Steel pails shall have welded sideseams, bottoms shall be doubleseamed. The top of the body shall be curled outwardly and shall present a smooth rounded surface for contact with the gasket in the cover. The cover with a flowed-in or tubular gasket, shall be of the lug type having a minimum of 6 lugs on the 5-pound size, 8 lugs on the 10-pound size and 12 lugs on the 25-pound size. One-pound and 5-pound containers shall be furnished without handles; the 10-pound and 25-pound sizes shall be furnished with galvanized wire handles of a minimum of 8 gage and shall be fitted with a suitable wood or metal hand grip. Handles shall be fastened to the sides of the pail by ears or clips securely soldered or welded into position. Containers manufactured of bonderized blackplate shall be coated on the inside with a baked-on enamel which shall neither affect nor be affected by the product packed. The exterior of containers shall be protected from corrosion by the application of a suitable baked-on corrosion-resistant enamel, and when tin content of solder is less than 30 per cent the sideseam of the 1-pound can shall be striped with corrosion-resistant enamel, except that for domestic shipment no exterior coating will be required on terneplate containers. The minimum gage of plate and approximate size and capacity shall be as follows:

G-1b. One-hundred-pound drums shall conform to the requirements of Interstate Commerce Commission Specification 37D, except that sideseams shall be welded.

G-2b. *For overseas shipment.*

G-2b(1). Unless otherwise specified, 25-pound pails and 100-pound drums shall be shipped without further packing.

G-2b(2). Unless otherwise specified, 1, 5, and 10-pound cans shall be packed in units of fifty 1-pound cans, twelve 5-pound cans, or six 10-pound cans in a cleated plywood box, nailed wood box, or wirebound box, conforming to the requirements of Sections V, VI and VIII, respectively, of Navy Department Specification 39P16, except that no waterproof liner will be required. In cleated plywood boxes, no drainage ducts in cleats will be required. Each box shall be strapped in conformance with the requirements of the applicable section of Navy Department Specification 39P16. Cans shall be separated within shipping containers by double face corrugated or solid fiberboard partitions and/or separator pads. Fiberboard shall conform to the requirements for Types V3C or V3S as described in Section VIII of Navy Department Specification 39P16.

That's the way the Navy has specified that grease shall be packed and that's the way the Navy wants it. It is realized, however, that there is a shortage of facilities in the country for making the five and ten pound pails and the Navy will, of necessity, have to take grease packed in containers other than specified. The grease in this instance should be packed in multiple friction top cans. Single friction top or full open friction top cans will not carry the material to its ultimate destination. Even when the multiple friction top can is used the plug should be soldered into place through the application of solder at three points equidistant around the periphery of the ring. This is necessary because most of the grease is overpacked in wood and the shock transmitted to the cans when the case is dropped pops the plugs resulting in a mess and loss of material. Reports back from overseas indicate that one of the worst packs in the Navy is the grease pack. This condition must be corrected. Not only is it costing money but the Navy loses valuable shipping space, loses material and worst of all loses the services of the equipment on which the grease would have been used had it arrived safely.

Capacity Pounds	*Diameter Inches*	*Body Height Inches*	*Gage of Metal* Body	*Bottom*	*Top*	*Plug*
1	3-3/8	4-1/2	90 pounds	90 pounds	100 pounds	95 pounds
5	5-5/8	5-7/8	28 gage	28 gage	28 gage	.....
10	7-7/16	6-3/8	26 gage	26 gage	26 gage	.....
25	11-1/4	9-3/16	26 gage	26 gage	26 gage	.....

The marking requirements are now in the process of standardization for lettering size and colors. Brand names will not be allowed. The specification title of the material will be the largest lettering on the container so that personnel can readily identify the material.

The Bureau of Supplies and Accounts is now purchasing greases for West Coast on and off shore shipments on semi-annual contracts. It is intended that such a procedure will be universally adopted. The advantages to be gained through semi-annual contracts are as follows:

(a) Manufacturers will know their monthly obligations in advance and can purchase raw materials, packages and containers and can arrange their production schedules more easily.

(b) Shipments can be made to transport loading piers directly thus reducing handling by Naval Supply Depots.

(c) Procurement at plants nearer to the point of rail delivery reduces long rail hauls by box car.

(d) Complete and prompt inspection of the product at source will be obtained.

(e) Local purchases can be eliminated.

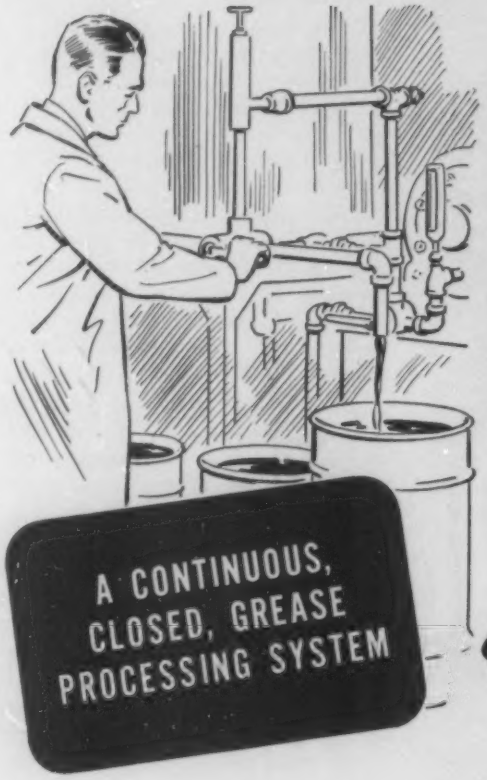
Everyone wants a general purpose grease including the Bureau of Ships and the development of such a material for shipboard use means saving of weight and space which is constantly sought for other equipment and stores. This general purpose grease should have:

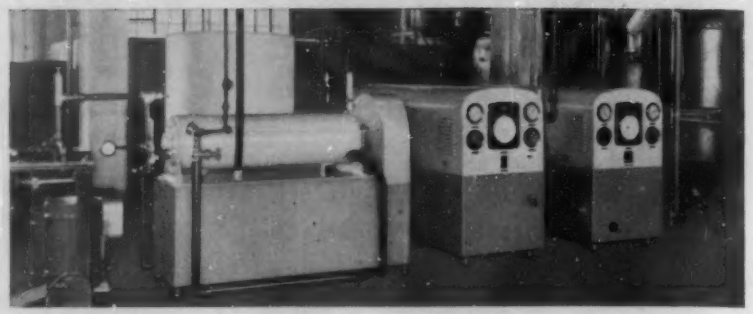
(1) Good oxidation and storage stability.
(2) Good low temperature and high temperature performance.
(3) Good E.P. properties.
(4) Non-creepage for electric motor bearings.
(5) Water resistance.
(6) No objectionable odor.
(7) Corrosion preventive properties.
(8) A grade 2 consistency.
(9) A reasonable price.

Research toward this end is being carried on with petroleum, non-petroleum, and soapless lubricants, and it is hoped that such a lubricant will be developed.

To a few present here, everything stated in this paper is "old stuff". Many of you, however, may find some helpful information for future contacts with the Navy with which, it is hoped, both you and the Navy will benefit.

Remember "Bureau of Ships does not want proprietary names on lubricant containers or in equipment instruction books."





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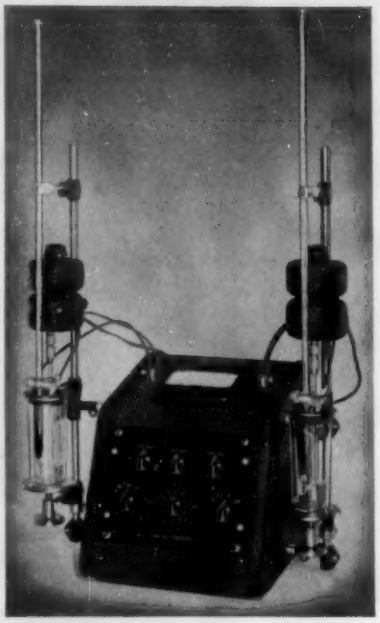

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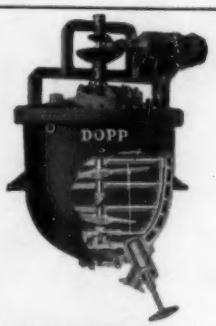

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